General

Guideline Title

ACR Appropriateness Criteria® metastatic bone disease.

Bibliographic Source(s)

Roberts CC, Weissman BN, Appel M, Bancroft LW, Bennett DL, Bruno MA, Fries IB, Germano I, Hayes CW, Holly L, Jacobson JA, Kransdorf MJ, Luchs JS, Morrison WB, Mosher TJ, Murphey MD, Palestro CJ, Rubin DA, Stoller DW, Tuite MJ, Ward RJ, Wise JN, Zoga AC, Lutz ST, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® metastatic bone disease. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 12 p. [67 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Roberts CC, Daffner RH, Weissman BN, Bancroft L, Bennett DL, Blebea JS, Bruno MA, Fries IB, Germano I, Holly L, Jacobson JA, Luchs JS, Morrison WB, Olson JJ, Payne WK, Resnik CS, Schweitzer ME, Seeger LL, Taljanovic M, Wise JN, Lutz ST, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® metastatic bone disease. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 11 p.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Metastatic Bone Disease

Variant 1: Stage 1 carcinoma of the breast. Initial presentation: asymptomatic.

Radiologic Procedure	Rating	Comments	RRL*
X-ray radiographic survey whole body	1		☢☢☢
Percutaneous biopsy area of interest	1		Varies
MRI area of interest without contrast	1		O
MRI area of interest without and with contrast	1		O
Tc-99m bone scan whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative**

Radiologic Procedure	Rating	Comments	RRL*
Myelography and post myelography CT spine	1		☢☢☢☢
FDG-PET/CT skull base to mid-thigh	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Stage 2 carcinoma of the breast. Initial presentation, with back and hip pain.

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9	To be done first to evaluate for presence of lesions suspicious for metastatic disease.	☢☢☢
X-ray spine and hip	9	Radiographs obtained after bone scan if needed for further lesion characterization.	☢☢☢
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and the results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
Tc-99m bone scan whole body with SPECT hip and spine	1		☢☢☢
Myelography and post myelography CT spine	1		☢☢☢☢
CT hips and spine without contrast	1		☢☢☢
CT hips and spine with contrast	1		☢☢☢
CT hips and spine without and with contrast	1		☢☢☢☢
X-ray radiographic survey whole body	1		☢☢☢
MRI hip and spine without contrast	1		O
MRI hip and spine without and with contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Breast carcinoma. Follow-up bone scan reveals single "hot" lesion in spine.

Radiologic Procedure	Rating	Comments	RRL*
X-ray spine hot area(s)	9		☢☢
MRI spine without contrast	9	If radiographs are negative.	O
FDG-PET/CT skull base to mid-thigh	5	If results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
MRI spine without and with contrast	1	Contrast can be useful if there is concern for extraosseous extension of tumor.	O
Myelography and post myelography CT spine	1		☢☢☢☢
Percutaneous biopsy spine	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative**

Radiologic Procedure	Rating	Comments	RRL*
CT spine without contrast	1		☢☢☢
CT spine with contrast	1		☢☢☢
CT spine without and with contrast	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Breast carcinoma. Three "hot" areas in spine revealed by bone scan. No back pain.

Radiologic Procedure	Rating	Comments	RRL*
X-ray spine hot area(s)	9		☢☢
MRI spine without contrast	9	If radiographs are negative.	O
FDG-PET/CT skull base to mid-thigh	5	If results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
SPECT spine	5	SPECT may be added to bone scan in equivocal lesions.	☢☢☢
MRI spine without and with contrast	1	Contrast can be useful if there is concern for extraosseous extension of tumor.	O
Percutaneous biopsy spine	1		Varies
Myelography and post myelography CT spine	1		☢☢☢☢
CT spine hot area without contrast	1		☢☢
CT spine hot area with contrast	1		☢☢
CT spine hot area without and with contrast	1		☢☢☢
X-ray radiographic survey whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: History of treated breast carcinoma. Now has single "hot" lesion in the sternum revealed by bone scan.

Radiologic Procedure	Rating	Comments	RRL*
CT sternum without contrast	9		☢☢☢
MRI sternum without contrast	8	If patient can tolerate prone imaging. Use of opposed-phase sequence is helpful to assess for marrow-obliterating process.	O
CT sternum with contrast	7	Contrast may be useful to delineate any soft-tissue extension and to direct biopsy.	☢☢☢
MRI sternum without and with contrast	7	Contrast may be useful to delineate any soft-tissue extension and to direct biopsy. See statement regarding contrast in text under "Anticipated Exceptions."	O
X-ray sternum	5	Difficult area to image with radiographs.	☢☢
FDG-PET/CT skull base to mid-thigh	5	If results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone SPECT	1		☢☢☢
CT sternum without and with contrast	1		☢☢☢
X-ray radiographic survey whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Patient with known bone metastatic disease (carcinoma of the breast). Presenting with pathological fracture of a femur on radiography.

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢☢☢
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and the results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
SPECT femur	1		☢☢☢
X-ray radiographic survey whole body	1		☢☢☢
CT femur without contrast	1		☢☢
CT femur with contrast	1		☢☢
CT femur without and with contrast	1		☢☢☢
MRI femur without contrast	1		O
MRI femur without and with contrast	1		O
X-ray femur	1		☢
Percutaneous biopsy femur	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 7: Prostate nodule on physical examination proven to be a well- or moderately differentiated carcinoma and PSA <20 mg/mL. Patient asymptomatic.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without contrast	1		O
MRI area of interest without and with contrast	1		O
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
Tc-99m bone scan whole body	1		☢☢☢
FDG-PET/CT skull base to mid-thigh	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Radiologic Procedure	Rating	Comments	RRL*

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 8: Prostate nodule on physical examination proven to be a poorly differentiated carcinoma or PSA ≥20 mg/mL. Patient asymptomatic.

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢☢☢
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
MRI area of interest without contrast	1		O
MRI area of interest without and with contrast	1		O
FDG-PET/CT skull base to mid-thigh	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 9: Patient with known malignancy, with back pain and partially collapsed vertebra on radiography. Otherwise healthy.

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without contrast	9	To differentiate osteoporotic collapse from destructive lesion.	O
Tc-99m bone scan whole body with SPECT spine	8	To detect additional lesions.	☢☢☢
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and the results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
MRI spine without and with contrast	1		O
CT spine without contrast	1		☢☢☢
CT spine with contrast	1		☢☢☢
CT spine without and with contrast	1		☢☢☢☢
Percutaneous biopsy spine	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 10: 1 cm lung nodule. Non-small-cell carcinoma found at needle biopsy. Now coming for staging and resection.

Radiologic Procedure	Rating	Comments	RRL*
FDG-PET/CT skull base to mid-thigh	9		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative**

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	4	Not needed if PET imaging is performed for initial nodule workup.	☢☢☢
MRI chest without contrast	1		O
MRI chest without and with contrast	1		O
X-ray radiographic survey whole body	1		☢☢☢
CT chest without contrast	1		☢☢☢
CT chest with contrast	1		☢☢☢
CT chest without and with contrast	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 11: Patient with multiple myeloma presenting with acute low back pain.

Radiologic Procedure	Rating	Comments	RRL*
X-ray lumbar spine	9		☢☢☢
MRI lumbar spine without contrast	8	Important if neurologic symptoms are present. Can help differentiate benign from malignant fractures.	O
X-ray radiographic survey whole body	2	If there has been a long interval since last bone survey.	☢☢☢
Tc-99m bone scan whole body	1		☢☢☢
CT lumbar spine without contrast	1		☢☢☢
CT lumbar spine with contrast	1		☢☢☢
CT lumbar spine without and with contrast	1		☢☢☢☢
MRI lumbar spine without and with contrast	1		O
FDG-PET/CT skull base to mid-thigh	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 12: Young patient with osteosarcoma of long bone coming for staging. Chest CT normal. Looking for bone metastases.

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢☢☢
MRI area of interest without contrast	9	MRI of surrounding region to evaluate for small skip metastases.	O
MRI area of interest without and with contrast	9	Contrast can be useful for delineating the soft-tissue extent of the primary osteosarcoma. See statement regarding contrast in text under "Anticipated Exceptions."	O
FDG-PET/CT skull base to mid-thigh	5	If bone scan is negative and MRI is equivocal, and if results of the PET examination will influence the use of systemic treatment.	☢☢☢☢
Tc-99m bone scan whole body with SPECT area of interest	1	SPECT may be added to nuclear medicine in equivocal lesions.	☢☢☢

Radiologic Procedure	Rating	Comments	RRL*
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 13: Osteosarcoma, resected clear margins. Chemotherapy, asymptomatic. Six-month follow-up after treatment to rule out bone metastases.

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m bone scan whole body	9		☢☢☢
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
MRI area of interest without contrast	1		O
MRI area of interest without and with contrast	1		O
Tc-99m bone scan whole body with SPECT area of interest	1		☢☢☢
FDG-PET/CT skull base to mid-thigh	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 14: Female, 8 weeks pregnant, with known primary, now suspected of having bone metastasis. She wants to continue with the pregnancy.

Radiologic Procedure	Rating	Comments	RRL*
MRI whole body without contrast	9	Should be done first due to lack of ionizing radiation.	O
X-ray area of interest	9	With appropriate shielding. Helpful to evaluate risk of pathologic fracture.	Varies
CT area of interest without contrast	2	If involving an extremity. With appropriate shielding.	Varies
Tc-99m bone scan whole body	2		☢☢☢
MRI whole body without and with contrast	1		O
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
X-ray radiographic survey whole body	1		☢☢☢
FDG-PET/CT skull base to mid-thigh	1		☢☢☢☢

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			
Radiologic Procedure	Rating	Comments	*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

There are several imaging and interventional techniques for the initial detection and follow-up of metastatic bone disease: radiography, radionuclide bone scanning, computed tomography (CT), magnetic resonance imaging (MRI), fine needle aspiration, and core needle biopsy. Newer techniques include fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET), FDG-PET/CT, and whole body MRI.

Except for a few limitations, radionuclide bone scanning remains the primary imaging examination used to detect osseous metastasis. It has been repeatedly shown to be more sensitive than plain radiography. Bone scans are sensitive in detecting osseous abnormalities, but they are nonspecific. After an abnormality has been detected, it should be radiographed to make sure it does not represent a benign process such as osteoarthritis, inflammatory arthritis, or fracture. One of the major advantages of radionuclide bone scanning is that it allows for a total body survey. This is important because approximately 13% of metastatic lesions occur in the appendicular skeleton in regions that are usually not included on a skeletal survey. One study pointed out that most metastatic skeletal lesions are asymptomatic and that the serum alkaline phosphatase level is a poor indicator of early metastases. Highly aggressive metastases may show "cold" or photopenic areas on a bone scan. Multiple myeloma can show photopenic lesions or a negative bone scan. Bone scans can also be relatively insensitive in detecting skeletal lesions due to Langerhans cell histiocytosis (histiocytosis X), and radiographic surveys are recommended for patients with this disease. Diffuse bony metastasis may present with a pattern of intense uniform radionuclide uptake (superscan), which has the potential to be misinterpreted as a negative examination.

Solitary sites of increased radionuclide uptake in patients with known malignancy are a common occurrence, and they may pose a diagnostic problem because of the nonspecific nature of these abnormalities on bone scintigraphy. On the other hand, one study reported that approximately 21% of patients with breast cancer relapsed with a solitary bone lesion, most commonly in the spine. The spine was the most common site for both solitary and multiple metastases. Another study reported that a solitary rib metastasis in cancer patients is uncommon and that 90% of "hot" rib lesions on bone scan are due to benign causes. A solitary sternal "hot" lesion in a patient with breast carcinoma has an 80% probability of being due to metastatic disease. When a patient with a known primary tumor develops a solitary lesion on a bone scan, further diagnostic evaluation should be undertaken, starting with radiography and, if that is not diagnostic, proceeding to CT, MRI, or even biopsy. Some authors advocate single photon emission computed tomography (SPECT) imaging as an effective method for differentiating malignant from benign lesions in the spine and for further characterizing equivocal lesions on bone scan throughout the body.

Breast Cancer

In stage 1 breast carcinoma where bone scintigraphy is usually negative, most authorities believe that routine baseline and follow-up bone scans are probably unwarranted because of the very low true positive yield. The panel does not recommend any imaging studies of the skeleton in asymptomatic patients with stage 1 carcinoma of the breast when they present initially. Bone scanning, SPECT, FDG-PET, and PET/CT have been shown to be useful in the preoperative staging and postoperative follow-up of stages 2, 3, and 4 breast carcinoma. FDG-PET has higher specificity than bone scintigraphy for metastases.

If a patient with stage 2 breast carcinoma presents with back and hip pain, the panel recommends radiography of the back and hip and radionuclide bone scan. Other studies may be needed depending on the results of the radiographs and bone scan. In patients with known breast carcinoma who are discovered to have a single "hot" area in the spine on bone scan, the panel recommends radiography of the "hot" area. If radiography is negative, the panel recommends MRI. For lesion localization and needle guidance, a CT scan is recommended if a needle biopsy is warranted. The panel recommends adding SPECT imaging if the planar radionuclide bone scan is equivocal. In patients discovered to have multiple "hot" lesions in the spine, the panel recommends radiography of the "hot" lesions; MRI is also recommended if the radiographic examination is negative. A CT scan becomes necessary if a needle biopsy is to be performed.

For a "hot" lesion of the sternum in a patient with known breast carcinoma, the panel recommends CT or MRI to help in the diagnosis. Radiographs are less useful for evaluation due to overlapping structures in this region. MRI should be performed with the patient prone to minimize respiratory artifact, and the use of an opposed phase (also referred to as in and out of phase) sequence is suggested to best assess for marrow replacement by tumor. CT is useful for localization if fine-needle aspiration or core biopsy is required or anticipated.

Long Bone Fracture

In a patient with known metastatic carcinoma presenting with a pathological fracture of a long bone on radiography, the panel recommends a radionuclide bone scan to look for other metastatic sites in the skeleton. CT or MRI can be useful for surgical planning and assessment of pathologic fracture risk in other regions.

Prostate Cancer

Studies have shown that for staging and follow-up of patients with prostate carcinoma, radionuclide bone scans are not necessary unless the prostate-specific antigen (PSA) is ≥20 mg/mL or the primary tumor is poorly differentiated. For routine staging purposes (no bone pain), the panel agrees with these studies. Thus, the panel recommends a radionuclide bone scan for patients with a PSA ≥20 mg/mL or a poorly differentiated primary tumor. The role of FDG-PET/CT and other PET isotopes continues to develop for staging.

Non-Small-Cell Lung Cancer

In patients with non-small-cell carcinoma of the lung, bone is one of the most common sites for early extrathoracic spread. Some of these bony metastases are asymptomatic. The exclusion of bone metastases is important in the initial preoperative staging of lung cancer, although it is not clear from the literature whether bone scans should be performed routinely or only when clinical indicators suggest skeletal metastases. The panel currently recommends a radionuclide bone scan of the skeleton in patients coming for staging after needle biopsy of a lung nodule revealed a non-small-cell carcinoma. However, in patients with non-small-cell carcinoma of the lung who have received or will be receiving an FDG-PET study as part of their initial work-up, a radionuclide bone scan is not necessary. The PET/CT literature supports this technique, showing that it has better accuracy than bone scintigraphy for staging non-small-cell lung carcinoma, especially for bone metastases.

Primary Bone Tumors

Bone metastases are very uncommon at initial presentation in patients with primary malignant bone tumors; therefore, radionuclide bone scan is not indicated. Bone scanning has been shown not to be useful in differentiating between benign and malignant lesions or in defining the local extent of a malignant tumor reliably. Osteosarcoma and Ewing sarcoma are probably the only exceptions; although the yield of imaging for metastases at the time of diagnosis is small, the presence of an occasional metastasis could substantially affect the treatment of the patient. The panel concurs with these reports and it recommends a radionuclide bone scan for patients with osteosarcoma or Ewing sarcoma at presentation for staging. In patients with osteosarcoma who received adjuvant chemotherapy, 16% may develop asymptomatic osseous metastasis before lung metastasis; therefore, some authors suggest bone scans for routine follow-up. The panel concurs with these reports, and it recommends a radionuclide bone scan for patients with osteosarcoma at follow-up and after tumor resection with clear margins and chemotherapy. FDG-PET has not been proven to replace chest CT and bone scanning as a staging modality for osteosarcoma.

Other Cancers

In patients with cancers that rarely metastasize to bone—such as cervical, endometrial, bladder, and gastrointestinal tract tumors—baseline scans are obtained only when the disease is advanced. There is no consensus in the literature about the timing of follow-up scans in asymptomatic patients. Some authors suggest a bone scan every 6 months for 1 year and then every 2 years. In clinical practice, most medical and radiation oncologists request follow-up bone scans only (a) in asymptomatic patients with evidence of progressive disease (i.e., rising carcinoembryonic antigen or alkaline phosphatase values), (b) for restaging the disease in patients with local recurrence, and (c) in patients with symptoms that are potentially of osseous origin. SPECT, SPECT/CT, or PET with various isotopes may also be useful depending on the primary tumor type.

Radiography is frequently used to screen for metastatic sites in multiple myeloma and Langerhans cell histiocytosis (histiocytosis X), but generally it is considered insensitive to screen for asymptomatic metastases. In patients with multiple myeloma who present with acute low-back pain, the panel recommends radiographs of the lumbosacral spine or bone survey if the interval since the last bone survey is long. MRI is useful in patients with neurological findings. The panel believed that the only time when radionuclide bone scan (with or without SPECT) would be needed in cases of multiple myeloma is when strontium 89 treatment is being considered.

Vertebral Column

The vertebral column deserves special consideration. It is the most common site of skeletal metastasis, and cord compression from metastasis is among the most dreaded complications of cancer. MRI has proven advantages over all other imaging modalities, including myelography and CT myelography, for detecting these conditions. One limitation of MRI has been its inability to consistently differentiate an acute traumatic or acute osteopenic compression fracture from a pathologic fracture, although certain characteristics can be suggestive in differentiating the two. The presence of enhancement on MRI has also not been proven to be a distinguishing feature. The use of diffusion-weighted MRI has been shown to be effective in differentiating benign osteopenic vertebral collapse from malignant collapse, but the efficacy of this technique is still controversial and it has not gained widespread use.

The role of FDG-PET and FDG-PET/CT has been assessed in metastatic disease of the spine. In patients with lung cancer, studies have shown

that FDG-PET has better specificity than bone scans using Tc-99m methylene diphosphonate (MDP) tracer, but similar sensitivity for detecting osseous metastatic disease. Additionally, FDG-PET/CT has better specificity for detecting metastatic involvement of the spine than FDG-PET. FDG-PET/CT allows precise localization of bone lesions and associated soft-tissue involvement with potential neurologic significance.

Whole-Body MRI

As MRI sequences continue to evolve, there is emerging evidence showing that whole-body MRI is feasible and that it could replace bone scintigraphy for detecting metastatic bone disease. Proponents of this technique indicate that whole-body MRI is equal to or more sensitive and more specific than bone scintigraphy or PET/CT. In addition to bone metastases, whole-body MRI can demonstrate silent metastases in the brain, lungs, and liver. Whole-body MRI is also comparable in cost to bone scintigraphy. No ionizing radiation is involved with whole-body MRI, making it especially suited for pregnant patients with suspected bony metastasis.

Depending on whether the lesion is lytic, blastic, or associated with a soft tissue mass, fine needle aspiration or core biopsy can be used to arrive at a definitive diagnosis in patients suspected of having metastasis of known or unknown origin. Needle biopsy is also helpful in suspected tumor recurrence and to differentiate metastasis from osteonecrosis in previously irradiated bone.

Summary

- Radionuclide bone scanning is the most widely used primary imaging examination for detecting osseous metastasis.
- After an abnormality has been detected, radiographs should be obtained to make sure the abnormality does not represent a benign process.
- If radiography is not diagnostic, additional lesion workup with MRI, CT, SPECT, or FDG-PET/CT is highly variable and should be based on the clinical situation and lesion location.

Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation
- ACR-ACOG-AIUM Practice Guideline for the Performance of Obstetrical Ultrasound
- ACR Manual on Contrast Media
- ACR Guidance Document for Safe MR Practices

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Abbreviations

- CT, computed tomography
- FDG-PET, fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography
- MRI, magnetic resonance imaging
- PSA, prostate specific antigen
- SPECT, single photon emission computed tomography
- Tc, technetium

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
☢	0 mSv <0.1 mSv	0 mSv <0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Metastatic bone disease

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Internal Medicine

Nuclear Medicine

Oncology

Radiology

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for metastatic bone disease

Target Population

Patients with metastatic bone disease

Interventions and Practices Considered

1. X-ray
    - Radiographic survey whole body
    - Spine and hip
    - Spine hot area(s)
    - Sternum
    - Femur
    - Lumbar spine
    - Area of interest
2. Percutaneous biopsy
    - Area of interest
    - Spine
    - Femur
3. Magnetic resonance imaging (MRI), without contrast and without and with contrast
    - Area of interest
    - Hip and spine
    - Spine
    - Sternum
    - Femur
    - Chest
    - Lumbar spine
    - Whole body
4. Myelography and post myelography computed tomography (CT) spine
5. Fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET)/CT skull base to mid-thigh
6. Technetium (Tc)-99m bone scan
    - Whole body
    - Whole body with single-photon emission computed tomography (SPECT) hip and spine
    - SPECT sternum
    - Whole body with SPECT spine
    - Whole body with SPECT area of interest
7. SPECT
    - Spine
    - Femur
8. Computed tomography (CT) without, with, and without and with contrast
    - Hips and spine
    - Spine
    - Spine hot area
    - Sternum
    - Femur
    - Area of interest
    - Chest
    - Lumbar spine

Major Outcomes Considered

Utility of radiologic examinations in differential diagnosis

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis, and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid, but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Modified Delphi Technique

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The ratings are a scale between 1 and 9, which is further divided into three categories: 1, 2, or 3 is defined as "usually not appropriate"; 4, 5, or 6 is defined as "may be appropriate"; and 7, 8, or 9 is defined as "usually appropriate." Each panel member assigns one rating for each procedure per survey round. The surveys are collected and the results are tabulated, de-identified and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. Consensus is defined as eighty percent (80%) agreement within a rating category. The final rating is determined by the median of all the ratings once consensus has been reached. Up to three rating rounds are conducted to achieve consensus.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Appropriate selection of radiologic examination procedures to evaluate metastatic bone disease

Potential Harms

Gadolinium-based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, an RRL indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection

of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Living with Illness

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Roberts CC, Weissman BN, Appel M, Bancroft LW, Bennett DL, Bruno MA, Fries IB, Germano I, Hayes CW, Holly L, Jacobson JA, Kransdorf MJ, Luchs JS, Morrison WB, Mosher TJ, Murphey MD, Palestro CJ, Rubin DA, Stoller DW, Tuite MJ, Ward RJ, Wise JN, Zoga AC, Lutz ST, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® metastatic bone disease. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 12 p. [67 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

1995 (revised 2012)

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

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Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Musculoskeletal Imaging

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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

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Guideline Availability

Electronic copies: Available from the American College of Radiology (ACR) Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 90 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria® metastatic bone disease. Evidence table. Reston (VA): American College of Radiology; 2012. 16 p. Electronic copies: Available from the ACR Web site.

Patient Resources

None available

NGC Status

This summary was completed by ECRI on May 6, 2001. The information was verified by the guideline developer as of June 29, 2001. This NGC summary was updated by ECRI on January 30, 2006. This NGC summary was updated by ECRI Institute on May 20, 2010. This summary was updated by ECRI Institute on January 13, 2011 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This NGC summary was updated by ECRI Institute on October 2, 2012.

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